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ABSTRACT

It was hypothesized that certain programmed productive thinking materials would increase both the divergent and convergent thinking abilities being measured and that there would be a direct relationship between any change in one of these abilities and any change in the other. Six classes of 6th-grade suburban students with I.Q.'s ranging from 79 to 149 were used as subjects and were assigned to treatment, placebo, or control groups. The treatment group worked individually on the programmed materials of Crutchfield's "The productive thinking program." The placebo subjects also worked individually on programmed booklets, but not on productive thinking. Four instruments from the Guilford battery were administered: Word-Group Naming, Sentence Order, Utility Test, and Word Arrangement. Results indicated that the null hypothesis should be accepted in each case. There appear to be educational implications for the nature of the programmed materials used, the use of Guilford's Structure of Intellect model in educational research, and in the relationship between divergent and convergent thinking abilities. These implications are explored in detail. (Author/LR)

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THE EFFECT OF PROGRAMMED PRODUCTIVE THINKING MATERIALS ON THE DIVERGENT AND CONVERGENT TEST SCORES OF SIXTH GRADE STUDENTS.[1]

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The purpose of the present study was to determine the effect of the use of programmed productive thinking materials by sixth grade suburban students on their performance with selected divergent and convergent thinking tasks. Crutchfield's (1965) The productive thinking program was used as the treatment materials.

It was hypothesized that the programmed productive thinking materials would increase a student's ability to perform selected divergent thinking tasks.

It was also hypothesized that the programmed productive thinking materials would increase a student's ability to perform selected convergent thinking tasks.

Finally, it was hypothesized that there would be a direct relationship between any change in the student's ability to perform selected divergent thinking tasks and any change in his ability to perform selected convergent thinking tasks.

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METHOD

Description of the Population

The school from which the subjects were selected is in a wealthy community made up largely of college-oriented families; almost 90 percent of the students go on to some form of post-graduate schooling. In selecting the Ss, the school principal was asked by the researcher to choose six teachers out of the total of nine who make up the sixth grade staff. The reason that random sampling was not used at this point was the desire to keep the study free from the contamination of a "lack of teacher cooperation" variable if at all possible. Given as ideal a set of circumstances as could be created, the study was designed to test the possibility of increasing the divergent and convergent productive thinking abilities of the sixth grade students in the population using the programmed materials in The productive thinking program. If the hypotheses that such abilities would be enhanced was supported, later studies might then look at the role of the teacher as a significant variable in the use of the materials.

Each of the classes taking part in the study consisted of between 26 and 28 students, roughly even as to girl-boy ratio, and assigned on a heterogeneous basis. The mean IQ for the six groups combined was 111 with a range of individual IQ's from 79 to 149. The six classes were assigned through the use of a table of random numbers into one of three groups: Treatment, Placebo, or Control.

Instruments Used in the Study

In selecting the instruments for this study consideration was given to the particular abilities being measured and also the nature of the subjects involved. The need to investigate the divergent and convergent operations emerged directly from the problem statement itself. The selection of semantic content came from both the importance of language during mental operation (Bruner, 1964) and the level and background of the population under study which indicated that verbally-oriented instruments would be suitable. The product categories of units and systems were selected to provide a balance between the more elementary (units) and the more complex (systems).

The specific factors studied consisted of:

Convergent Production

NMU = Convergent Semantic Units

NMS = Convergent Semantic Systems

Divergent Production

DMU = Divergent Semantic Units

DMS = Divergent Semantic Systems

The instruments used to measure these factors came from the Guilford (1967) battery and consisted of

Word-Group Naming (NMU) - Reliability: .61.

Sentence Order (NMS) - Reliability: .57.

Utility Test (fluency (DMU) - Reliability: .74.

Word Arrangement (DMS) - Reliability: .70

For this study, test scores on the four factors were combined to give two scores: one for convergent and one for divergent

production. In order to use the tests for both pre- and post-testing, the instruments were divided in half.[2] The time allotments were increased by approximately 25 percent to compensate for the age level.

Experimental Treatment

Each of the six classes were administered the pretest battery two days prior to the use of the experimental treatment. Administration was under the supervision of the researcher and all tests were scored by him. Following the procedures used by Crutchfield (1965), The productive thinking program was passed out twice a week on nonconsecutive days and the students were given whatever time they needed to complete the booklet being worked on that day. As there are 16 booklets in the series, the treatment period lasted for eight weeks.

The placebo subjects were handled in the same manner as the treatment subjects, but the materials used were not designed to develop productive thinking ability. The materials were however, programmed, self-administered by the students, and worked on for two nonconsecutive days each week for eight weeks. Like the treatment materials, the placebo was geared toward the interest level of sixth graders.

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[2]It was recognized that this procedure would reduce the reliability of each test used; however, despite this limitation, this procedure seemed desirable because alternate forms of the tests did not exist.

The control group that did not receive any additional materials to work with went ahead with their regular program during the eight week period of treatment.

The Treatment of the Data

Since pretreatment ability as well as IQ were anticipated as possible factors of contamination, an analysis of covariance was used to test the first two null hypotheses. Pretreatment ability, as measured by the pretests, and IQ, obtained from the students' records, were used as the covariates in the analyses. Aside from the independent variable of treatment, a secondary consideration involved the possible influence of sex either directly or as an interaction influence on the results. For this reason, factorial design was included. The posttest scores, converted into Z scores and combined, were the data used to obtain the residual mean squares and F values. Significance was set at the .05 level.

Since the differences tested for the first two hypotheses did not reach statistical significance,[3] the third null hypothesis was tested by selecting all students in the sample who advanced in convergent and/or divergent ability. These scores were then analyzed using the Pearson product-moment coefficient. Significance was again set at the .05 level.

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[3]See Discussion of the Results.

DISCUSSION OF THE RESULTS

A brief survey of the results, as seen in the tables presented at the end of this paper, gives fairly strong support to each of the null hypotheses for this study. No significant differences were found.

The Implications for Productive Thinking

Tables V and VI, concerning the correlation between divergent and convergent production, support Guilford's (1967) view of problem solving as having more than a single unitary dimension. While a number of students did demonstrate an increase in divergent ability over the course of the eight week period, no statistically significant relationship was found either directly or inversely to a change in their convergent ability. The same was true when an increase in convergent ability was correlated with any change in divergent ability. This lends support to the position that these are distinct entities, largely independent of each other, with independent functional capabilities. The findings also might add evidence to the results found by investigators such as Getzels and Jackson (1962), Taylor and Holland (1967), and Solomon (1968) who found that creativity and intelligence, as measured by IQ tests, were not closely correlated. This possible support for those who found creativity and intelligence as two separate entities must, however, be tempered with the same caution that Cronbach (1968) used in his discussion of the Wallach-Kogan study to the effect

that great care should be exercised in the use of labels--especially such general labels as "creativity" and "intelligence." On this basis, a more accurate inference from the present study would be that convergent semantic production, when units and systems are combined into a single measure, is not the same ability as divergent semantic production, again with units and systems combined into a single measure. Further, assuming that both of these are present in productive thinking (Guilford, 1967), the evidence of the present study indicates that they can be increased separately without necessarily affecting each other. Therefore, the assumption that helping a student develop one of these abilities will also help him increase the other is open to serious question.

The Implications for The Productive Thinking Program

In their discussion of creativity, Getzels and Madaus (1969) speak quite positively toward The productive thinking program. On the other hand, Treffinger and Ripple (1969) failed to find any significant changes when they used the program with students in grades four through seven. The present study tends to support the latter point of view, but certain qualifying points should be kept in mind. In the first place, the Covington-Crutchfield study and the Treffinger-Ripple study were attempts to measure the master thinking skill itself and the instruments were designed for that purpose. The present study was designed to measure two specific abilities, semantic divergent and semantic convergent thinking, which have not as yet been shown to be related to the master thinking skill. Therefore, although there is justification to conclude

that The productive thinking program did not in this instance improve the students' ability in either specific area tested, the possibility still exists that a number of other skills could be improved through the use of the materials.

Another point is that Crutchfield (1965) felt that problem solving entails "a synthesis of divergent and convergent thinking . . . [p. 16]." If problem solving takes place only through a synthesis process, there is the possibility that a student's synthesizing ability can be sharpened, and thus his problem solving ability, even though there has not been a change in the specific skills that make up either divergent or convergent production. Further investigation into the relationship between these abilities would prove worthwhile in helping to answer this question.

Possible Influences on the Results of the Study

In order to gain further insight into the study and the materials used, each participating teacher was asked to contribute a few comments concerning various aspects of the eight week investigation. One aspect included the request to indicate the students' attitude toward the treatment or placebo materials as the study progressed. In the treatment group, only 13 students were noted as retaining a high interest throughout while as many as 38 were felt to have become bored to some extent as the weeks passed. Six students never seemed to become very interested in the materials at all. Essentially the same pattern was found among the placebo group which also used programmed materials. Eleven were

rated as maintaining interest throughout while 41 were felt to have lost interest as the period progressed.

A second factor, the elimination of teacher support and encouragement in the use of the materials, could very well have influenced the results, especially when considered in light of the tendency toward boredom just discussed. Had the teachers in the treatment and placebo groups taken an active part in the learning process during the use of the programmed materials, the results might possibly have shown significance not found in the present study. However, this would have made the testing of the first two hypotheses essentially impossible and was therefore discouraged by the researcher. Further study of teacher effect on programmed materials would possibly show the desirability of using or not using this influence. From a general observation of the present study, this researcher would surmise that teacher influence would prove to be a strong factor in the success or failure of most programmed materials in the development of student abilities such as those investigated here.

Another area of possible influence on the results of the present study is the question of the time spent using the materials. The basis for using the booklets twice a week for a total of eight weeks came from Crutchfield (1965) who describes the success found in the Covington-Crutchfield sampling under these conditions. In the present study the average daily time spent amounted to about 40 minutes which means that over the total of 16 booklets in the program, each child spent approximately 11 hours using this form

of instruction. The idea that materials used for such a relatively short period can result in a measurable change in either the divergent or convergent ability of a number of students was not supported by the present study. Perhaps expansion of the materials so that they may constitute a part of the daily school program over a longer portion of the year might considerably increase their effectiveness. A suggestion was made by one of the teachers from the treatment group that the materials might be valuable if used as a base for a reading program or possibly as supplementary reading material for use during reading time. Additional booklets and/or expansion of the present materials would open this as a possibility.

The Implications for Education

Perhaps the strongest implication of the present study for education comes from the testing of the third hypothesis concerning the relationship between a change in one type of productive thinking and a change in the other. Since no significant relationship was demonstrated between an increase in one ability and an increase (or decrease) in the other, there is considerable support for the idea voiced by Torrance (1968) and others that there is a need to create environments to help students develop both their ability to do divergent thinking and their ability to do convergent thinking. If schools persist in concentrating on one form or the other, there is considerable doubt that they will be meeting the needs of the individual to develop all of his abilities to whatever capacity he is capable of reaching. If a significant

relationship does not in fact exist for most populations, no matter how much a student develops his ability in one, there would be little justification for believing he is therefore developing the other.

Another implication is that neither the Crutchfield materials nor the placebo materials, when used in the manner of this study, appear to be especially effective in increasing the divergent or convergent thinking ability of students similar to those used here. A count of the number of students who improved during the experimental period in either convergent or divergent ability indicates that the control sample, which did not use any programmed materials during the period, had approximately as many demonstrate improvement as did either of the other two groups (see Table VII). This study was not designed to evaluate the use of programmed materials compared to other types of classroom learning aids, but if the programmed method had been particularly effective, the two samples using that type of instructional device should have seen a larger number of students improve than the control sample where none was used. Also, as mentioned previously, a considerable difference might have been seen if the teachers had played a role in the use of the programmed materials. Perhaps the best approach at present would be one of cautious optimism that looks forward to further development of these kinds of materials and further research into their effect on a student's productive thinking ability.

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TABLE I

Means and Standard Deviations for Three Samples of Sixth Grade Students on a Battery of Convergent and Divergent Tests Divided by Sex

Sample		Convergent				Divergent			
		Pretest		Posttest		Pretest		Posttest	
	N	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Treatment, Boys	28	96	19	97	13	91	11	93	13
Treatment, Girls	25	101	14	98	17	107	21	101	15
Placebo, Boys	28	99	16	102	16	99	12	103	17
Placebo, Girls	25	109	12	102	17	100	13	101	15
Control, Boys	28	100	15	103	15	102	15	99	18
Control, Girls	26	97	15	100	17	101	19	104	16

TABLE II

Means and Standard Deviations for Three Samples of Sixth Grade Students on a Battery of Convergent and Divergent Tests with Boys and Girls Treated as a Single Sample

Sample		Convergent				Divergent			
		Pretest		Posttest		Pretest		Posttest	
	N	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Treatment	53	99	16	98	15	99	16	97	14
Placebo	53	104	14	102	16	100	12	102	16
Control	54	99	15	102	16	102	17	102	17

TABLE III

Analysis of Covariance with Factorial Design for the Divergent Thinking Ability of Sixth Grade Students

Source of Variation	Sum of Squares	df	Mean Square	F	sig.
Treatment	5494.71	2	2747.36	1.05	n.s.
Sex	2514.43	1	2514.43	0.97	n.s.
Interaction	8329.34	2	4164.67	1.60	n.s.
Within	395978.57	152	2605.12		

TABLE IV

Analysis of Covariance with Factorial Design for the Convergent Thinking Ability of Sixth Grade Students

Source of Variation	Sum of Squares	df	Mean Square	F	sig.
Treatment	26781.97	2	13390.98	1.94	n.s.
Sex	6831.80	1	6831.80	0.99	n.s.
Interaction	28711.84	2	14355.92	2.08	n.s.
Within	1051334.55	152	6916.67		

TABLE V

Pearson Product-Moment Correlation Coefficients Showing the Relationship between an Increase in Divergent Thinking Ability by Sixth Grade Students and a Change in Their Convergent Thinking Ability

Sample	N	mean gain	S.D.	r	95% conf. limit		sig.
Boys:							
Convergent	44	3.4	16.5	.10	-.21	.39*	n.s.
Divergent		13.2	10.3				
Girls:							
Convergent	36	-3.8	15.7	-.01	-.33*	.31	n.s.
Divergent		12.4	10.7				
Combined:							
Convergent	80	.2	16.5	.03	-.19	.25*	n.s.
Divergent		12.8	10.9				

*$p < .05$

TABLE VI

Pearson Product-Moment Correlation Coefficients Showing the Relationship between an Increase in Convergent Thinking Ability by Sixth Grade Students and a Change in Their Divergent Thinking Ability

Sample	N	mean gain	S.D.	r	95% conf. limit		sig.
Boys:							
Convergent	47	14.1	11.0	.02	-.26	.30*	n.s.
Divergent		3.3	15.0				
Girls:							
Convergent	29	12.8	9.5	-.03	-.40*	.35	n.s.
Divergent		-1.6	12.8				
Combined:							
Convergent	76	13.6	10.4	.02	-.22	.25*	n.s.
Divergent		1.3	14.3				

*$p < .05$

TABLE VII

Number of Students Who Improved in Divergent or Convergent Ability Divided by Samples

Sample	Convergent Increase	Divergent Increase
Treatment	25	23
Placebo	24	32
Control	27	25